35 U.S.C. § 112, Second Paragraph

Claims 1-7 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention. As a result of Applicant's amendments of claims 1-7 and the addition of claim 8, claims 1-7 now particularly point out and distinctly claim the subject matter which Applicant regards as the invention. The above amendments to claims 1-7 and the addition of claim 8 address the specific concerns recited in the Office Action dated December 19, 2002. Therefore, Applicant requests reconsideration and withdrawal of this rejection of claims 1-7 under 35 U.S.C. § 112, second paragraph.

Claims 1-5 were rejected under 35 U.S.C. § 112, second paragraph, as being incomplete for omitting essential steps, such omission amounting to a gap between the steps. The Office Action asserts that the omitted steps relate to steps for designing an arm structure as mentioned above. Applicant requests reconsideration of this rejection.

Applicant asserts that a step of selecting a vertical region and a step of selecting a length of the arm and the height of the axis of rotation are both steps in designing an arm structure. Accordingly, Applicant respectfully requests reconsideration and withdrawal of the rejection of claims 1-5 under 35 U.S.C. § 112, second paragraph, since claims 1-5 do not omit essential steps.

Claims 6 and 7 were rejected under 35 U.S.C. § 112, second paragraph, as being incomplete for omitting essential elements. The Office Action asserts that the omitted elements are the elements which define the arm structure discussed above. Applicant requests reconsideration of this rejection.

Claim 6 recites an arm structure comprising an arm which can rotate vertically and forward over a prescribed angle around an axial line extending substantially between two shoulders. Accordingly, this claim defines the arm structure and does not omit any elements. Accordingly, Applicant requests reconsideration and withdrawal of the rejection of claims 6 and 7 under 35 U.S.C. § 112, second paragraph.

The amendments to claims 1-7 are cosmetic in nature and are not intended to narrow the scope of the claims. The claim amendments were made only to address the rejections under 35 U.S.C. § 112, second paragraph.

35 U.S.C. § 102(b)

Claim 1 was rejected under 35 U.S.C. § 102(b) as being anticipated by Gretz et al. (U.S. Patent No. 4,967,126). In making this rejection, the Office Action asserts that this reference teaches each and every element of the claimed invention. Applicant respectfully requests reconsideration of this rejection.

Claim 1 recites a method for designing an arm structure for a robot having an arm which can rotate vertically and forward over a prescribed angle around an axial line extending substantially between two shoulders. The method includes selecting a vertical region in front of the robot that can be accessed by the arm in a fully extended state, the location of the selected vertical region being determined with respect to a reference plane. The method also includes selecting a length of the arm and a height of the axis of rotation of the arm based on the selected region so that a range of rotational motion of the arm in accessing the selected region can be covered by a range in which

the fore-and-aft distance to the tip of the arm can be linearly approximated. The height of the axis of rotation is measured from the reference plane.

Gretz teaches a method of controlling a seven degree of freedom manipulator arm. This arm is formed from two links 12 and 14 connected by a two degree of freedom rotational joint 16. The base link 12 is attached to the ground 20 by a two degree of freedom rotational joint 18 at a base point 22. Figure 1 illustrates the four joint angles which are denoted θ_1, θ_2, θ_3, and θ_4 (Gretz, column 2, lines 50-63).

Gretz uses homogeneous transformation matrices derived from Denavit-Hartenberg parameters that were multiplied together to produce a vector R that connects base point 22 with tip 24. As a result, the precise location of tip 24 may be calculated using the following equations:

$$X = L_1c_1s_2 + L_2 (c_1s_2c_4 - s_1s_3s_4 + c_1c_2c_3s_4)$$

$$Y = L_1s_1s_2 + L_2 (s_1s_2c_4 + c_1s_3s_4 + s_1c_2c_3s_4)$$

$$Z = L_1c_2 + L_2 (c_2c_4 - s_2c_3s_4)$$

where c_1 denotes $\cos\theta_1$, c_2 denotes $\cos\theta_2$, c_3 denotes $\cos\theta_3$, c_4 denotes $\cos\theta_4$, s_1 denotes $\sin\theta_1$, s_2 denotes $\sin\theta_2$, s_3 denotes $\sin\theta_3$ and s_4 denotes $\sin\theta_4$ (Gretz, column 3, lines 3-20).

Applicant has carefully reviewed Gretz and can find no other equations or methodologies utilized to determine the position of tip 24 with respect to base 22. The above equations utilizing sin and cos of the four positioning angles shown in Figure 1 provide the precise position of tip 24. The precise position output from these equations, however, does not teach and/or suggest that the range of rotational motion of the arm in

accessing a selected region can be covered by a range in which the fore-and-aft distance to the tip of the arm can be linearly approximated.

In reviewing Gretz, Applicant also could not find any disclosure and/or suggestion that an arm structure for a robot should be designed by selecting a region in front of the robot that can be accessed by the arm in a fully extended state, the location of the selected vertical region being determined with respect to a reference plane. In particular, Applicant carefully reviewed column 2, line 50, through column 3, line 67, cited in the Office Action. In the event that this rejection is maintained, Applicant respectfully requests that the Examiner provide a specific location in Gretz that teaches selecting a vertical region in front of the robot that can be accessed by the arm in a fully extended state.

Applicant respectfully requests reconsideration and withdrawal of this rejection since Gretz fails to teach and/or suggest each and every element of the claimed invention. Specifically, Gretz fails to teach and/or suggest selecting a vertical region in front of the robot that can be accessed by the arm in a fully extended state. Gretz also fails to teach and/or suggest selecting a length of the arm and a height of the axis of rotation based on the selected region so that a range of rotation motion of the arm in accessing the selected region can be covered by a range in which the fore-and-aft distance to the tip of the arm can be linearly approximated. Therefore, Applicant respectfully requests reconsideration and withdrawal of the rejection of claim 1 under 35 U.S.C. § 102(b).

New Claim

New claim 8 has been added to further claim Applicant's invention. This claim is allowable for at least the reasons discussed above. Accordingly, Applicant respectfully requests consideration of new claim 8.

Conclusion

Applicant's amendments and remarks have overcome the rejections set forth in the Office Action dated December 19, 2002. Specifically, Applicant's remarks and amendments to claims 1-7 and the addition of claim 8 overcome the rejection of claims 1-7 under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention. Applicant's claim amendments and remarks have also overcome the rejection of claims 1-7 under 35 U.S.C. § 112, second paragraph, as being incomplete for omitting essential steps and/or essential elements (two different rejections). Applicant's remarks have distinguished claim 1 from Gretz and thus overcome the rejection of this claim under 35 U.S.C. § 102(b). New claim 8 has been added to further claim Applicant's invention. Accordingly, claims 1-8 are in condition for allowance. Therefore, Applicant respectfully requests consideration and allowance of claims 1-8.

Applicant submits that the application is now in condition for allowance. If the Examiner believes that the application is not in condition for allowance, Applicant respectfully requests that the Examiner contact the undersigned attorney by telephone if it is believed that such contact will expedite the prosecution of the application.

The Commissioner is authorized to charge payment for any additional fees which may be required with respect to this paper to our Deposit Account No. 01-2300, making reference to attorney docket number 101213-00019.

Respectfully submitted,

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Enclosure: Marked-Up Copy of Amended Claims

MARKED-UP COPY OF AMENDED CLAIMS

1. (Amended) A method for designing an arm structure for a robot having an arm which can rotate vertically and forward over a prescribed angle around an axial line extending substantially between two shoulders, the method comprising [the steps of]:

selecting [defining] a vertical [extent of a] region in front of the robot that can be accessed by the arm in a fully extended state, the location of the selected vertical region being determined with respect to a reference plane; and

selecting [determining] a length of the arm and a height of the axis of rotation of the arm based on the selected region so [in such a manner] that a range of rotational motion of the arm in accessing the selected region can be covered by a range in which the fore-and-aft distance to the tip of the arm can be linearly approximated, wherein the height of the axis of rotation is measured from the reference plane.

2. (Amended) A method for designing an arm structure for a robot according to claim 1, wherein a height of the axis of rotation of the arm is [about] 910 mm, and the arm is adapted to swing vertically at least by 240 mm at its free end both upward and downward from a horizontal line.

3. (Amended) A method for designing an arm structure for a robot according to claim 8 [2], wherein a maximum tolerated error of the fore-and-aft distance of the free end of the arm is 15 mm, and the arm is at least 528 mm long, and [adapted to swing] swings at least ± 27 degrees from a horizontal line.

4. (Amended) A method for designing an arm structure for a robot according to claim 8 [2], wherein a maximum tolerated error of the fore-and-aft distance

of the free end of the arm is 20 mm, and the arm is at least 422 mm long, and [adapted to swing] swings at least ±35 degrees from a horizontal line.

5. (Amended) A method for designing an arm structure for a robot according to claim 8 [2], wherein a maximum tolerated error of the fore-and-aft distance of the free end of the arm is 25 mm, and the arm is at least 365 mm long, and [adapted to swing] swings at least ±42 degrees from a horizontal line.

6. (Amended) An arm structure for a robot [having] comprising:

an arm which can rotate vertically and forward over a prescribed angle around an axial line extending substantially between two shoulders, wherein:

a height of the axis of rotation of the arm is [about] 910 mm, and the arm [is adapted to swing] swings vertically at least by 240 mm at its free end both upward and downward from a horizontal line.

7. (Amended) An arm structure for a robot according to claim 6, wherein the arm is at least 365 mm long, and [adapted to swing] swings at least ±42 degrees from a horizontal line.

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